# SPECIALIZED SAMPLING AND SEPARATIONS USING 3M MEMBRANE TECHNOLOGY

## TECHNOLOGY NEED

The need for field characterization is growing fast in the DOE complex as activities to remediate sites, treat stored waste, and decontaminate facilities increase. Minnesota Manufacturing and Mining Corporation (3M) and Argonne National Laboratory (ANL) have demonstrated success in the development of membrane technology to greatly expand testing capabilities, maintain data quality, and lower per sample costs.

It has been estimated that the DOE spends over $300 million per year to run over a million analytical samples in support at 4000 locations. The cost per sample is divided more or less equally between collection and transportation costs and the price charged by the analytical lab. In addition to the need to manage the total cost, there is a desire to run even more samples for improved characterization and decision-making.

## TECHNOLOGY DESCRIPTION

Since 1989, 3M has incorporated state-of-the-art solid-phase extraction (SPE) technology into commercial products for laboratory analytical sample separations. Empore™ Environmental Sample Preparation Disks have become the standard of the SPE industry for responding to EPA methods for water analysis. Disks exist for radionuclides including strontium, radium, and technetium. Recent modifications of the Empore™ disk technology have included the development of appropriate sampling and field-use devices. These devices provide significant improvements and advantages by applying proven laboratory sample preparation techniques to field sampling.

3M separation technology, under the commercial Empore™ brand membranes, provides the capability of removing contaminants down to lower threshold detection levels at high flow rates in the presence of high levels of radiation. The technology, which may be used for the preparation of samples for analysis, the remediation of contaminated liquids, or the retrieval of valuable materials, depends on the ability to make effective separations using small nominal 10-micrometer particles of adsorbers of various classes. The sorbent is loaded into a membrane that is used in a filtration-like process and is used as a flat disk for analytical sample preparation and subsequent analyses.

This project is focused upon the sample analyses and not for the development of membranes for improved cartridges containing membranes used to remove contaminants from groundwater.

## BENEFITS

The end-user sampling needs have been identified from site personnel input and incorporated into the overall design and performance specifications. From the results to date, DOE can expect to realize the following benefits based on the successful implementation of the field sampler:

- Rapid deployment of available technology for characterization purposes with user-friendly systems.
- Higher productivity of samples per day over conventional sample preparation procedures.
- Reduced sample turnaround from weeks to days or hours due to the preparation steps being accomplished at the time of sampling.
- Increased analytical accuracy and precision.
- High rate of incorporation of technology into practice.
- Efficient sampling (>95 % of analyte retained).
- Selective capture of analyte eliminates potential interferences associated with conventional analytical sample preparation.

- Ability to achieve lower detection levels of analyte by control of sample volumes processed through the membrane.
- Reduced costs in sample handling and analyses.
- Compact, transportable and rugged for field usage.

## CAPABILITIES/LIMITATIONS

Gaining approval of the new field sampler technology for characterization methods by regulators has been addressed. 3M has a long-term working relationship with EPA in the area of separation procedures. This is demonstrated by the incorporation of 3M membranes in over 20 published and several EPA accepted methods for water analyses. Up-front inclusion of both end-users and regulators helped in defining technical performance specifications in the initial stages of the project. This Quality for Deployment (QFD) procedure for developing the technology and products to meet stakeholders needs greatly accelerated the program and supported DOE's goal for rapid and successful technology implementation

## COLLABORATIONS/TECHNOLOGY TRANSFER

3M and Argonne National Laboratory jointly developed the rapid water sampling and analysis system based on Empore™ membrane solid-phase extraction (SPE) technology. Rapid water sampling methods and equipment based on Empore™ SPE membranes have been developed for representative radionuclides and heavy metals. 3M and Argonne had earlier demonstrated their productivity as a team through a series of Cooperative Research and Development Agreements (CRADAs) focused on stream-lining radiochemical analysis in the laboratory and generating improved and simplified waste minimization procedures.

As part of the commercialization process, the technology was demonstrated in the field with end-users being trained on the use and benefits of the field sampler. Throughout the deployment activities, several partnerships were developed with DOE, national labs, and various sites of concern to ensure that the needs of the problem holders, regulators and end-users were met.

One area of commercial deployment identified is time-weighted remote sampling. A field study has been initiated between Savannah River Site (SRS), ISCO, and 3M. The objective is to combine the field sampler device with the automated, remote sampling system of ISCO. There are approximately 50,000 ISCO samplers in place throughout the world. SRS alone accounts for over 100 of these units which actively sample various locations throughout the site. The interfacing of the two sampling schemes will advance unattended sampling into another dimension. The ability to selectively capture dissolved analytes over time using the compact field-sampling device in series adds a powerful and cost effective means of determining ongoing changes of a particular sample stream. The results to date are extremely promising and the degree of success is very high due to the commercial track record of the two technologies.

The developments have been accomplished through several cost sharing agreements between the interested parties.

SRS technical personnel have presented field sampling data on numerous occasions such as at bioassay and analytical equipment conferences.

## ACCOMPLISHMENTS

Technetium and lead were chosen as the demonstration analytes. Rugged polypropylene holders for membrane disks were fabricated and demonstrated in a prototype sampling system. Demonstrations were performed at four sites in 1997: Paducah, Kentucky; Savannah River, South Carolina; West Valley, New York; and Morris, Illinois. Improvements in the system stimulated by each use were implemented in the next demonstration. Data collected showed comparable results between the disk and baseline methods.

In addition, on-site analysis techniques using disk color development and portable self-indicating membranes were initiated in laboratory studies. A field transportable beta spectrometer was also demonstrated.

The commercialization/deployment plans consists of several important milestones: move baseline laboratory technology into the field (onsite), incorporate end user interaction throughout the development process, identify and understand user value, establish parameter performance targets, and submittals for regulatory acceptance.

These sites are currently using the available commercial laboratory disks for routine analyses and have readily accepted the concept of incorporating the field sampler into their sampling/monitoring program. Since membranes already exist for separating some of the radioactive analytes, the implementation discussions with end-users held during the development tasks have been accomplished with a minimal amount of effort.

Based on the results obtained during Phase I of the program, significant advantages of the 3M Empore™ selective separation technology translate into direct economic benefits. A cost benefits analysis summary for the radiation laboratory disk technologies has been developed. Another cost benefit analysis on the rapid, liquid sampler is planned.

Awards received for the technology developed under this program include the Industrial Research and Development 100 Award in 1996 and the Federal Laboratory Consortium Award in 1997. Major publications, presentations, and regulatory endorsements also were successfully completed throughout the development of the field sampling technology.

## TECHNICAL TASK PLAN (TTP) INFORMATION

TTP No./Title: FT06C261 - Specialized Sampling and Separations Using 3M Membrane Technology. Earlier work by Argonne National Laboratory supporting the project was performed under TTP No. CH27C221.

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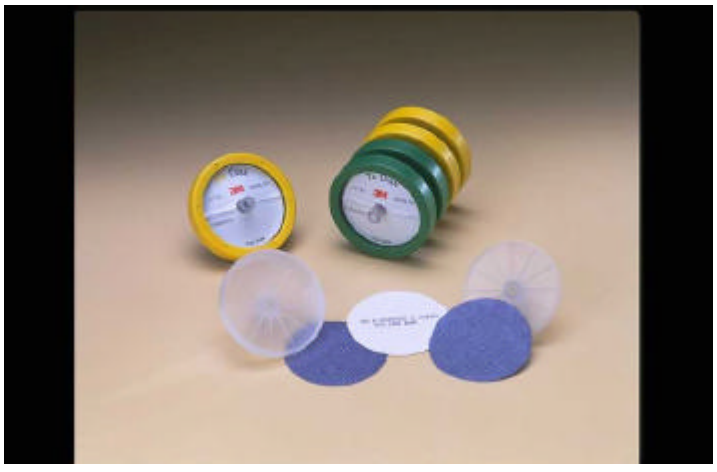

**Exploded View of Rapid Liquid Sampler (RLS) Components**

**Portable Radioactive Contaminant Sampling System Fits in Carrying Case on Right**